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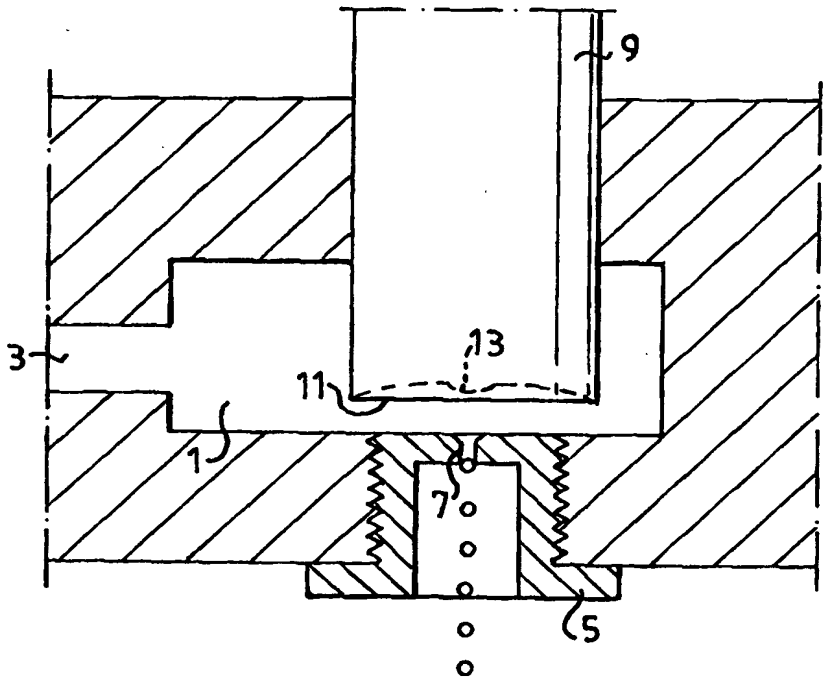
(54) Title: DEVICE FOR APPLYING DROPS OF A FLUID ON A SURFACE

(57) Abstract

In a device for ejecting small amounts of a liquid material having accurately defined volumes from a chamber (1), the chamber has a nozzle aperture (7) and a rod (9) is mounted in or attached to a wall of the chamber (1), so that an end surface (11) of the rod is located opposite and at a small distance of the nozzle aperture (7). A driving device is coupled to the rod (9) for displacing the end surface (11) forwards and backwards inside the chamber with a very small stroke, with a high acceleration and a large force, so that a pressure wave is formed and propagates in the material in the chamber (1). The pressure wave then ejects material out of the nozzle aperture (7).



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DEVICE FOR APPLYING DROPS OF A FLUID ON A SURFACE

The present invention relates to a device for placing small volumes of a material being in a liquid or fluid shape such as viscous media and liquid dispersions, in particular a viscous dispersion such as solder paste and different kinds of glues and adhesives, with a high speed on a substrate or base by ejecting drops of the material from a chamber through a nozzle.

BACKGROUND

When mounting electronic components on printed circuit boards and substrates it can be required that small isles or patches of solder paste are placed with a high speed and a high accuracy on such a base. Also, depositing varnishes and glues, in particular an electrically conductive adhesive, can be required. The high speed is required for the ever higher speed at which the electronic devices of today are produced.

In the published International patent application WO91/12106 a device is disclosed for depositing material, which comprises a rod, the length of which is changed when it is subjected to a suitable magnetic field. The end of the rod forms one wall of a chamber filled with the material. When the length of the rod is suddenly changed to become longer, the volume of the chamber is changed and the material is in the shape of a drop pressed out of a nozzle. In the published International patent application WO90/00852 instead the volume of the chamber is changed by making the chamber of a piezo-electrical material and subjecting it to an electric field.

In the European patent document EP-B1 0 517 767 a device is disclosed for depositing drops of a liquid material such as solder paste, glue and similar materials. The device comprises a rigid metal pipe through which material flows and which contains a nozzle in a wall of the pipe, and it further comprises a rod resting at the outside of the pipe conduit and made of an magnetostrictive material. By subjecting the rod to a magnetic field it will change its length to produce a blow on the outside of the pipe thereby locally increasing the pressure in the pipe, so that a drop of the material is ejected through the nozzle.

In U.S. patent US-A 5,320,250 a method is disclosed for rapid dispensing of small amounts of a viscous material. A chamber containing the material has a nozzle in a wall and another wall of the chamber has the shape of a flexible, elastic

diaphragm. An impact mechanism such as an electrically actuated hammer hits against the outside of the diaphragm in order to produce a change of the volume of the chamber, so that a drop is pressed out of the nozzle.

SUMMARY

It is an object of the invention to provide a device by means of which small amounts of a liquid or fluid material can be ejected from a chamber containing the material, so that one drop at a time can be ejected in an accurately defined volume or so that the liquid material is ejected in a finely divided shape.

Thus, in a device for dispensing small quantities or amounts of a material a chamber is provided having a nozzle aperture arranged in a first wall. The chamber has a second wall which is opposite and parallel to the first wall. A rod is movably mounted in or attached to the second wall in such a way that one end surface of the rod and a neighbouring portion of the envelope surface of the rod are located inside the chamber. This end surface is furthermore opposite the nozzle aperture. An actuating device is coupled to this rod in order to displace it through a short distance forwards and backwards or otherwise produce, e.g. by changing the length of the rod. Then the one end surface of the rod moves forwards and backwards inside the chamber, in the longitudinal direction of the rod, perpendicularly to the one end surface. The diameter or largest cross dimension of the rod is advantageously large compared to the diameter of the nozzle aperture. The length of stroke of the rod or equivalently the displacement of the end surface of the rod is small but the stroke movement is made with a high acceleration and a large force, so that a pressure wave is thereby formed and propagates in the viscous medium. When hitting the inlet of the nozzle channel, the pressure wave then ejects material through the nozzle. The ejection of the material is thus primarily produced by a pressure wave or a pressure shock which propagates in the material and not by a change of the volume of the chamber. Furthermore, in order that the pressure wave will efficiently act towards the nozzle aperture the end surface of the rod is advantageously located close thereto. Thus, the distance between the end surface of the rod and the inlet of the nozzle aperture is preferably small

compared to the diameter of the end surface. Said diameter can be taken as equivalent to the largest dimension of the end surface as taken in a cross direction of the rod, i.e. from an edge of the end surface to an opposite edge thereof.

The displacement of the rod or its end surface can easily be produced maintaining a high accuracy of the movement without having it degraded because of wear or plays in bearings and similar reasons. Examples of suitable driving devices are electrostrictive, piezo-electrical, magnetostrictive actuators and memory metal actuators.

BRIEF DESCRIPTION OF THE DRAWING

The invention will now be described by way of a non limiting embodiment with reference to the accompanying drawing, in which

Fig. 1 is a schematic cross sectional view of a device for feeding or depositing material.

DETAILED DESCRIPTION

In Fig. 1 a chamber 1 made in a rigid metal block is shown, which through an opening 3 in a side surface is connected to a material container, not shown. The chamber 1 has the shape of a low cylinder having side surfaces and a top wall and a bottom wall. In the bottom wall there is a narrow outlet or nozzle aperture 7. The aperture 7 can be a channel in a nozzle 5 which is attached in a bore in the bottom wall by means of suitable cooperating threads. The nozzle 5 has a nozzle aperture 7 in the shape of a narrow channel. The inner end of the nozzle channel 7 which is located at the chamber is bevelled or shaped as a funnel. Opposite the inner end of the channel 7 a rod 9 is located. The rod 9 is slidably mounted in the wall opposite the wall in which the nozzle 5 is located, i.e. the rod is mounted in the top wall of the chamber 1. The lower end surface 11 of the rod 9 can move in directions towards and away from the nozzle 5 and the bottom wall by means of some suitable driving device or by the very construction of the rod together with a suitable actuator, not shown. For example the rod itself or its driving device, if all of the rod is to be displaced, can be based on electrostrictive, piezoelectrical or magnetostrictive materials. Some portions of the rod or driving mechanism can also be based on memory metals.

Then, if the lower end surface 11 of the rod 9 is given a sudden, very small movement downwards, towards the bottom wall

and the nozzle 5, in particular towards the inner end of the channel 7, a localized pressure increase or pressure blow or shock is obtained in the material in the chamber 1 close to the lower end surface 11 of the rod 9. A shock wave is thus generated in the material in the chamber and it propagates therein away from the end surface 11, in a direction substantially perpendicular thereto. This pressure increase or pressure wave then also affects, for a suitable dimensioning, that region of the chamber 1, at which the inner channel 7 of the nozzle 5 mouths in the chamber 1. Thereby a particulate quantity such as a drop of the material in the chamber 1 will be ejected from the nozzle channel 7 at its other, outer end. The particulate quantity of material will then move freely with a high velocity in air along a path substantially coinciding with the prolongation of the longitudinal axis of the straight channel 7. The quantity can hit and thus be applied to some substrate, not shown, for example a printed circuit board or some other substrate having electrical conductor parts. In order that the pressure increase or pressure wave will efficiently act towards the nozzle channel 7, the end surface 11 of the rod 9 can be located at only a small distance of the region in which the nozzle channel 7 starts inside the chamber 1, compared to the diameter of the rod or more particularly to the diameter of its end surface. Thus, the distance can be comprised within the range of 0.05 - 0.5 mm, the diameter of the end surface 11 for example being 1 - 4 mm. The diameter of the end surface 11 is also large in relation to the diameter of the narrowest portion of the nozzle channel, which can be comprised within the range of 0.1 - 0.5 mm. Furthermore, the length of stroke of the end surface 11 is small compared to the diameter thereof, for example at most 0.01 - 0.02 mm.

The nozzle 5 is in Fig. 1 made as a threaded bushing having a basically cylindrical shape. The inner side of the nozzle is substantially flat at the surface surrounding the centrally located, coaxial channel 7. A deep cylindrical, coaxial recess is in the opposite side of the cylindrical nozzle which faces away from the chamber 1. The nozzle channel 7 then extends only a short way through the inner portion of the nozzle 5, having its outer end surrounded by the walls of the recess. The nozzle channel 7 is thus located directly connected to the main space

of the chamber 1 having its inner end located in the plane of the bottom wall, what results in that a pressure increase in the chamber 1 can easily be directed, so that it will efficiently affect the nozzle channel. Other detail solutions and attachment methods of the nozzle are naturally conceivable. The end surface 11 of the rod 9 is furthermore made as a substantially flat surface located perpendicularly to the longitudinal axis of the rod and to the longitudinal axis of the channel 7 and in parallel to the inner surface of the nozzle 5 and the bottom wall and has its centre located straight above the nozzle channel 7. In particular those regions of the chamber wall which are located at and close to the inner end of the channel 7, these regions comprising the inner, upper surface of the nozzle 5, are substantially flat and have an extension at least corresponding to the extension of the end surface 11. These regions are also parallel to the end surface 11 of the rod 9. The longitudinal axes of the rod 9 and of the channel 7 can thus coincide. The end surface 11 of the rod can also be modified to comprise a concave, centrally located, shallow recess for producing an enhanced localisation of the pressure increase or a better definition of the direction of the pressure shock. Centrally in the recess in the end surface 11 a small and low, projection portion or boss 13 can be arranged, which can further increase the intensity of the pressure shock in the region centrally below the end surface 11 and thus close to the inner end of the nozzle channel.

CLAIMS

1. A device for applying a fluid, a viscous medium or a dispersion as drops on a substrate, comprising

a chamber intended to contain the material to be applied,

a nozzle aperture in a first wall in the chamber,

characterized by

a rod mounted in or attached to a second wall of the chamber, the rod having an end surface and an envelope surface connecting to the end surface, the second wall being opposite the first wall, so that an end surface of the rod and a connecting portion of the envelope surface are located inside the chamber and the end surface is opposite the nozzle aperture, and

driving means coupled to the rod to act thereon for driving the end surface of the rod to move forwards inside the chamber towards the nozzle aperture.

2. A device according to claim 1, **characterized in** that the rod and/or the driving means are so configured that when the driving means are not active, the end surface of the rod returns to an original position thereof, the end surface then performing a movement backwards inside the chamber away from the nozzle aperture.

3. A device according to any of claims 1 - 2, **characterized in** that the length of stroke of the end surface of the rod in its movement forwards and/or backwards respectively is significantly smaller than the diameter or largest cross dimension of the end surface.

4. A device according to any of claims 1 - 3, **characterized in** that the diameter or largest cross dimension of the end surface is large compared to the diameter of the narrowest portion of the nozzle aperture.

5. A device according to any of claims 1 - 4, **characterized in** that the distance between the end surface of the rod and the end of the nozzle aperture inside the chamber is small compared to the diameter or largest cross dimension of the end surface.

6. A device according to any of claims 1 - 5, **characterized in** that the driving means coupled to the rod are made so that the movement of the end surface is produced having a high acceleration and with a large force.

7. A device according to any of claims 1 - 6, **characterized**

in that the nozzle aperture is made so that material passing through the opening is accelerated to a large velocity.

8. A device according to any of claims 1 - 7, **characterized in** that the end surface of the rod has a substantially flat shape.

9. A device according to any of claims 1 - 7, **characterized in** that the end surface of the rod is made so that it, in the movement of the end surface in a direction towards the nozzle aperture, produces a focusing of a pressure wave in the material inside the chamber in a direction towards the nozzle aperture.

10. A device according to claim 9, **characterized in** that the end surface of the rod comprises a concave, centrally located, shallow recess.

11. A device according to claim 10, **characterized in** that the recess in the end surface of the rod comprises a low projecting portion located centrally in the recess.

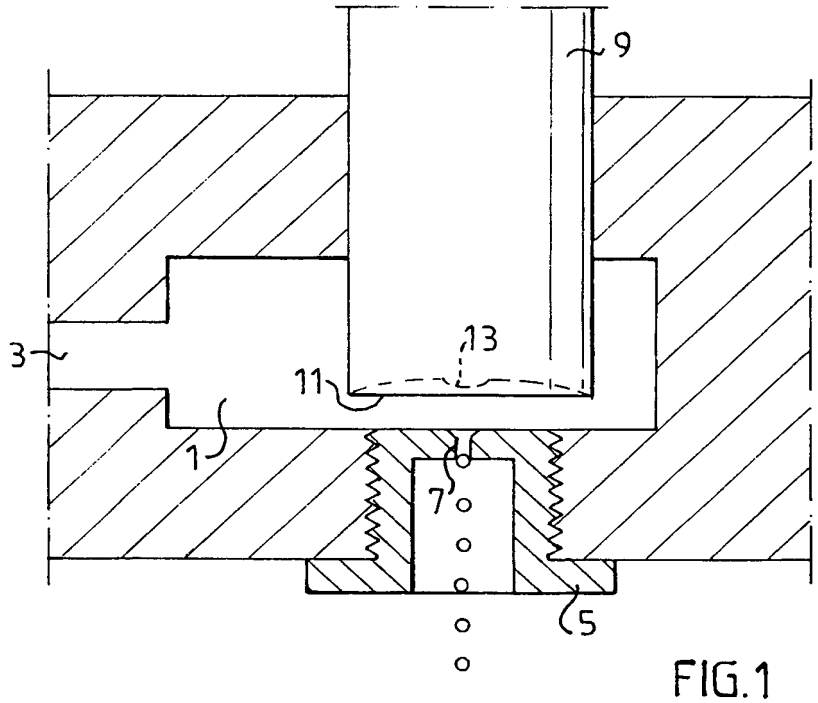

FIG.1

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 97/01738

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B05C 5/02, B23K 3/06
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B05C, B23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9112921 A1 (QUENICO AB), 5 Sept 1991 (05.09.91), page 5, line 14 - line 18, figure 2, abstract --	1
A	WO 9112106 A1 (MYDATA AUTOMATION AB), 22 August 1991 (22.08.91), abstract -- --------	1

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

07/01/98

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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